Energy Storage

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DARPA / DoD Army

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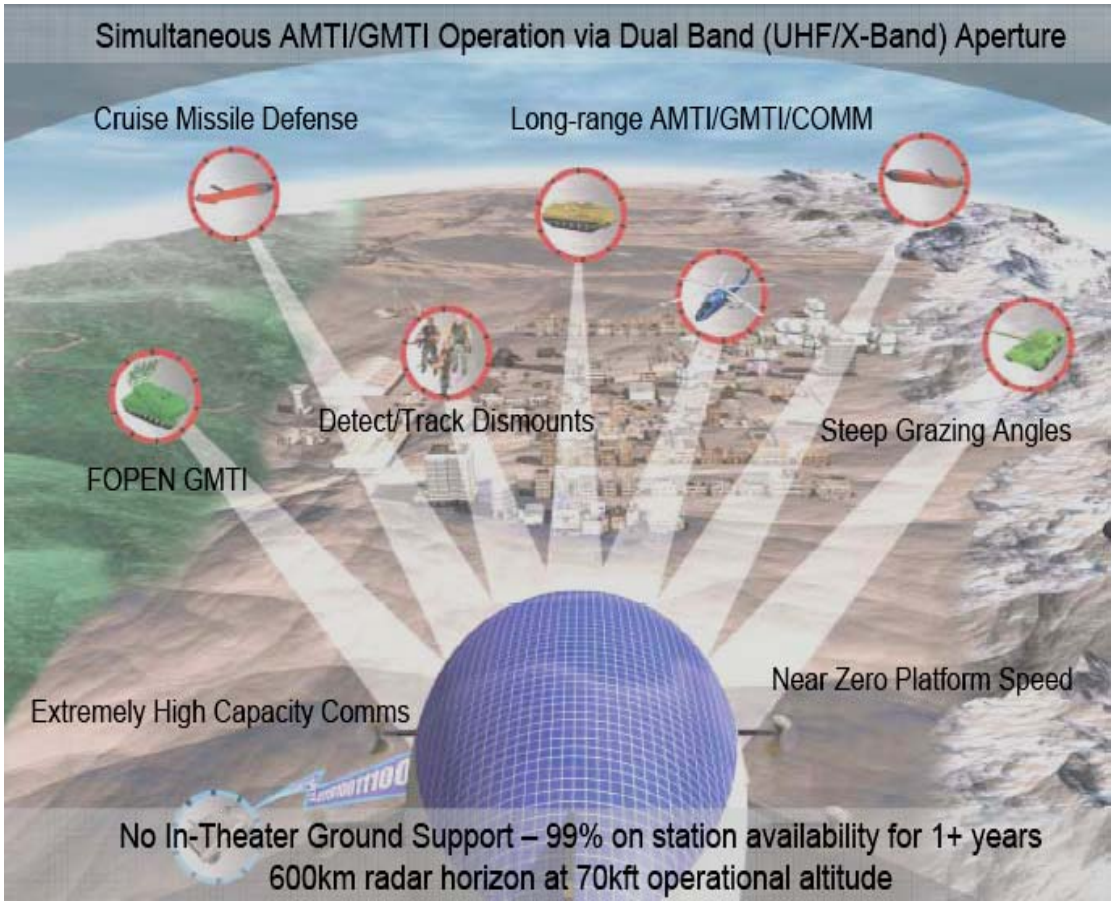
Problem

Situational awareness is critical to making the right decisions at the right time. Aerial surveillance is a key aspect of this mission, but is currently expensive to maintain on a 24/7/365 basis. Airships can provide this capability for extended durations. New technologies are required to reduce mass, generate and store usable power, and produce enormous radar arrays in a lighter-than-air environment to support 24/7/365 missions.

Background

Integrated Sensor Is the Structure (ISIS)

Most Powerful Airborne GMTI/AMTI Radar and Comms Ever Conceived



- **Airship-based radar**
  - Altitude: ~70,000 ft.
  - 600 km radar horizon
  - Steep grazing angles for GMTI
  - Stationary
    - Detect slow or stationary targets
    - No dropouts
    - Develop clutter maps
- **Airship**
  - Accommodate ultra-large aperture
  - Sensitive radar / COMM platform
- **Unmanned**
  - Minimum logistics trail
  - Mission duration: 1+ years
  - 99% Station availability
  - No crew at risk

Objective

DARPA Objective:

Provide unsurpassed situational awareness through the use of high-altitude, unmanned airships that are designed to provide high-reliability, unattended, on-station surveillance

MITRE Activities:

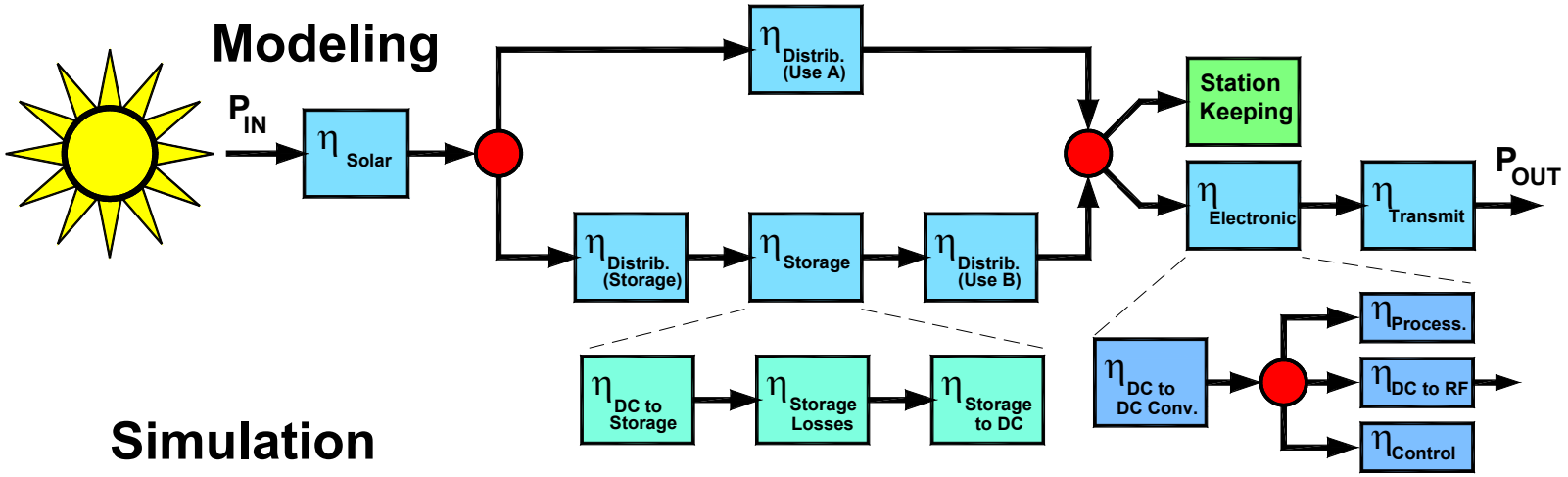
Provide DARPA technical support for energy generation and storage systems, modeling and simulation, sensor systems studies/analysis (e.g., phenomenology, related technology, reliability, etc.)

Activities

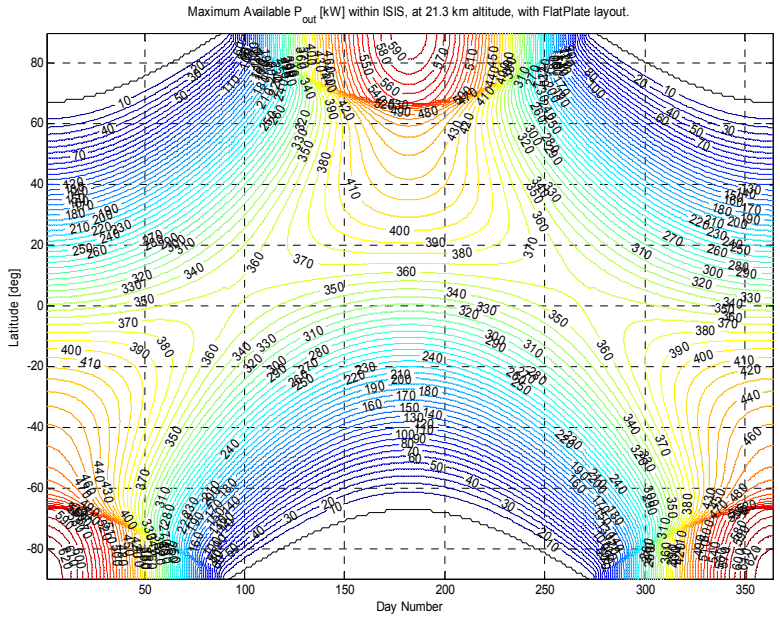
- **Modeling & Simulation:**
  - Solar availability
  - Effective airship solar surface area
  - System energy model
  - Sensor capabilities
  - Reliability
- **Technology**
  - Energy sources, conversion, and storage
  - Sensor phenomenology
  - Materials and process technology
  - Implementation
- **System Engineering Support**
  - Feasibility and impact
  - Trade space analysis
  - System optimization

Highlight

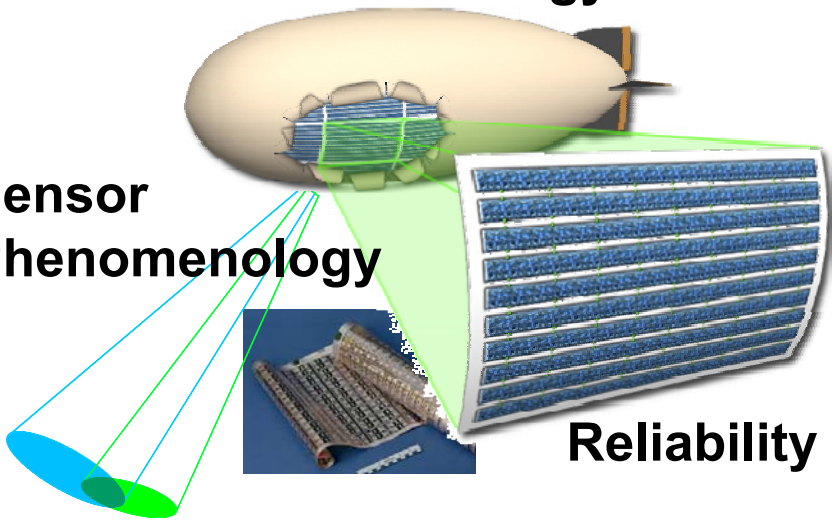
Modeling



Simulation



Technology



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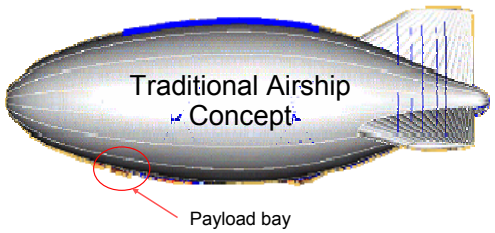
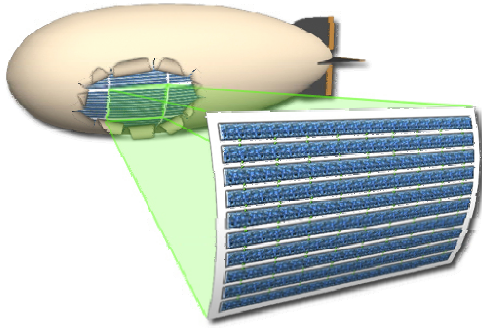
Demonstration

Capability cannot be added to airship after development



Payload: 1.7% of system mass

ISIS requires integration of sensor and airship



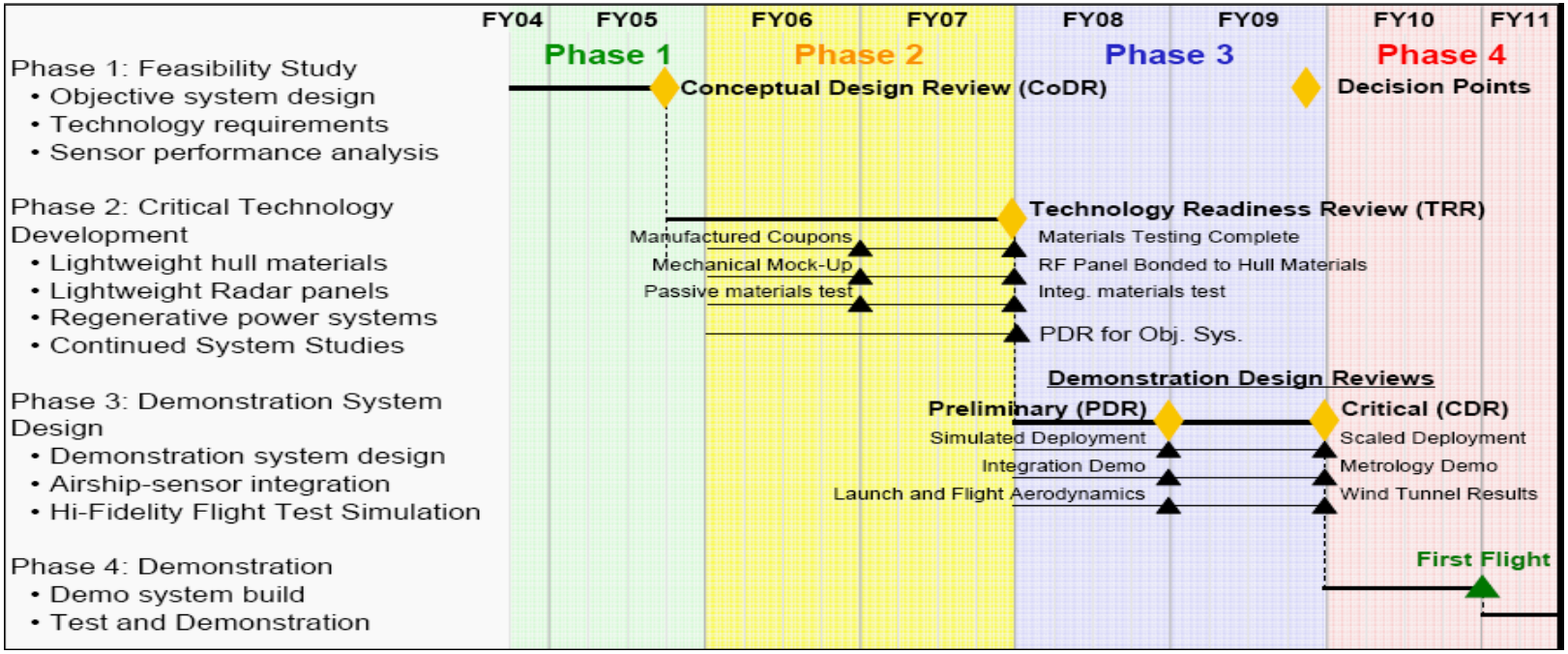
Payload: 30-40% of system mass

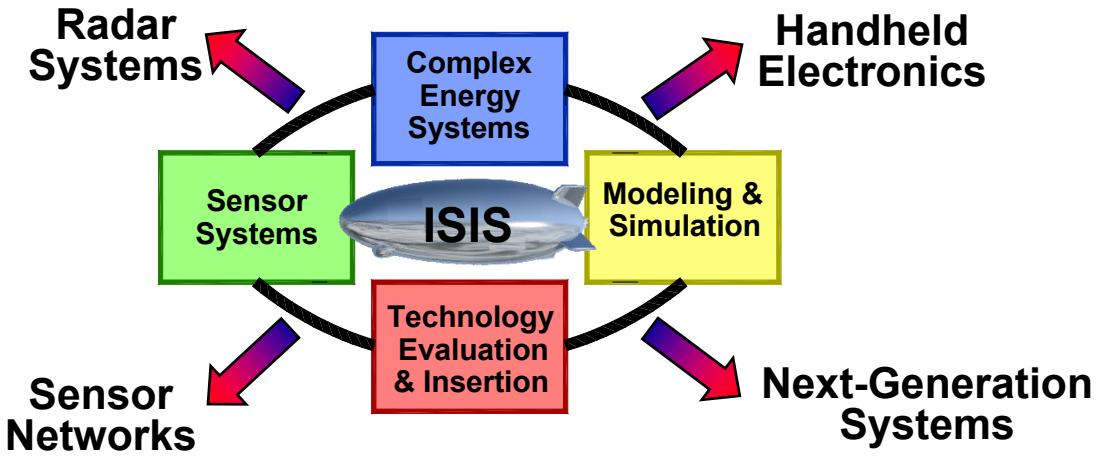
- **Payload-platform integration provides 12dB reduction in system mass**
  - **Traditional airship concept: ~2% payload → ISIS: 30-40% payload**
- **10dB reduction in radar aperture mass**
  - **Current RF-on-flex state of the art is 20 kg/m^2→ ISIS is 2 kg/m^2**
- **6dB reduction in airship hull mass**
  - **Current state of the art is 400 g/m^2→ ISIS is ≤100 g/m^2**
- **Fully regenerative power system for near-space**
  - **ISIS is ≥400 W-hr/kg**

Impacts

- Energy generation and storage, technology integration, systems analysis, and sensor phenomenology are key technology thrusts for the DARPA ISIS platform as well as other systems to follow.
- The concept of energy generation and high-density energy storage is of interest to many MITRE sponsors.
- Renewable energy system research is a high priority for decreasing America's dependence on foreign oil.
- The concept of using the structure (airship) as an integral part of the sensor in order to minimize weight has application in many areas such as UAVs, antennas, electronic packaging, etc.

Future Plans





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